RESOURCE INNOVATION INSTITUTE

UTILITY BEST PRACTICES GUIDE LAUNCH

In partnership with

ACEEE American Council for an Energy-Efficient Economy

USDA United States Department of Agriculture
Natural Resources Conservation Service

March 17, 2022

Agenda

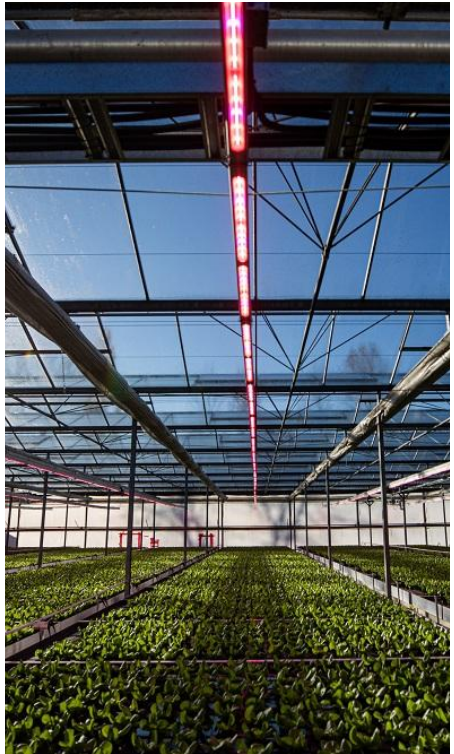
Welcome & Purpose	1:00 pm ET
Introductions & Context	1:05 pm ET
Utility Best Practices Guide Takeaways	1:10 pm ET
Making a Business Case for CEA Programs	
CEA Program Design	
Lighting & HVAC Measures	
CEA Facility Baselines	
Savings Methodologies for CEA Program Offerings	
Incentive Structure	
Strategic Energy Management	
Resource Benchmarking CEA Facilities	
CEA Program Market Engagement	
Breakout Sessions, Q&A	1:50 pm ET

SECTION 01

WELCOME & PURPOSE

About RII

- Objective, data-driven non-profit
- Founded 2016 in Portland, Oregon
- Expertise in climate policy, utility programs, green building certification, sustainable business, construction & indoor cultivation
- In 2020, received 3-year grant from USDA to develop KPIs, standards & building rating system for CEA



ABOUT RII

What We Do / Our Mission

We measure, verify & celebrate the world's most efficient agricultural ideas.

Measure

Efficiency & Productivity

- Key Performance Indicators
- Benchmarks
- Baselines

Verify

Best Practices & Standards

- Training
- Policies
- Utility Programs

Celebrate

Leadership Recognition

- Verification
- Case Studies
- Certification

Our Network

Governments
Resource Suppliers
Efficiency Programs
Producers
Supply Chain
Standards

INPUT from industry leaders and partners
RESOURCE INNOVATION INSTITUTE
EDUCATION and advocacy about best practices for growers

RII Technical Advisory Council

Multi-disciplinary body who aggregates knowledge to support producers and other stakeholders with objective and peer-reviewed data and curriculum on benchmarking resource efficiency

- **Guides** development of standards
- **Shapes** tools and resources to support best practices
- **Advocates** for informed policies, incentives and regulations

HVAC - Lighting - Utility - Water
Policy - Data - Controls - Emissions
Facility Design & Construction

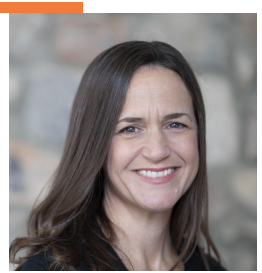
SECTION 02

INTRODUCTIONS & CONTEXT

Today's Speakers

Gretchen Schimelpfenig

RESOURCE INNOVATION INSTITUTE



Jeannie Sikora

CLEAResult®

Jenn Amann

ACEEE American Council for an Energy-Efficient Economy

Lauren Morlino

Evergreen Consulting Group

Evan Gutierrez

TRC

RII Utility Working Group 2022 Charter

To advance best practices for controlled environment agriculture efficiency programs to support producers to overcome barriers to efficiency, promote efficiency for producers in compelling ways, and develop baselines for resource productivity and efficiency of CEA facilities to achieve persistent savings, decarbonization and emissions reductions goals and CEA market transformation.

ICF
LANSING BWL
resource innovations
nationalgrid
SOUTHERN CALIFORNIA EDISON
NEW YORK STATE OF OPPORTUNITY. NYSERDA
Consumers Energy
Energy Solutions
DNV
DTE
ACEEE American Council for an Energy-Efficient Economy
TRC
MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE
Efficiency Vermont
veic
EnSave
Evergreen Consulting Group
GDS Associates, Inc. ENGINEERS & CONSULTANTS
EVERSOURCE
D+R International
CLEAResult
FRANKLIN ENERGY

CEA Utility & Efficiency Program Best Practices Guide

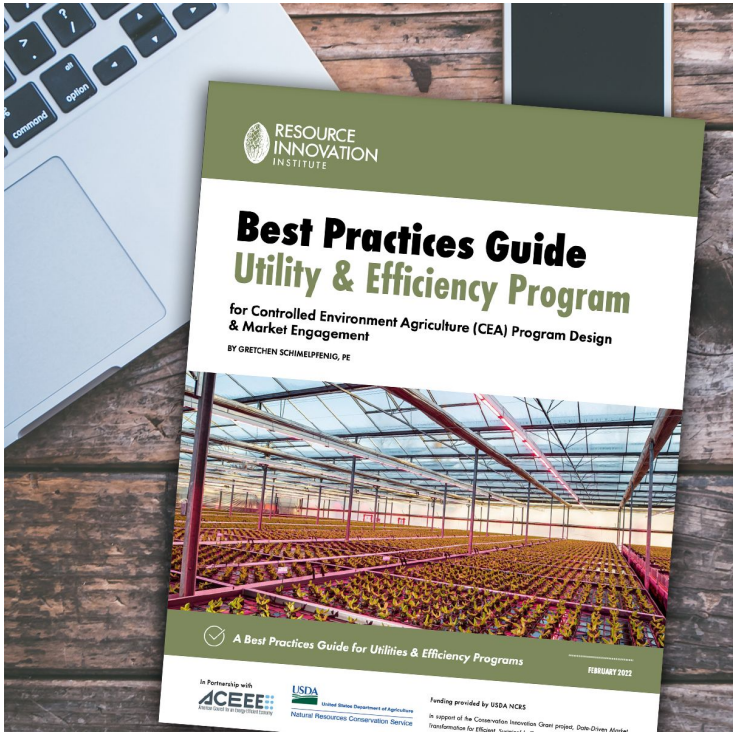
Access the Guide in the RII Catalog

Featuring contributions from 17 Utility Working Group member companies

Peer reviewed by 7 CEA key market actor organizations

Funded via USDA CIG grant

- Access it for free on the RII catalog
- Share with your network
- Review the Appendix to learn about efficiency programs across the United States
    - Eligible equipment
    - Incentive structures



Cannabis Utility & Efficiency Program Primer

Published in 2020

Peer-reviewed guidance for specialized energy efficiency programs and incentives for cannabis production facilities

Contributions from Utility Working Group member companies

Funded via RII membership

- Access it for free on the RII catalog

Purpose of Today's Workshop

Utilities & Efficiency Programs are Key CEA Market Actors

- Identify the range of approaches efficiency program administrators are taking as they engage the market
- Emphasize key areas of consideration for efficiency program design and implementation
- Outline opportunities for research, program design and implementation, and regional/national coordination in four key areas:
  - Resource acquisition
  - Emerging technologies
  - Market transformation
  - Utility & efficiency program policy

Energy Suppliers

Efficiency Programs

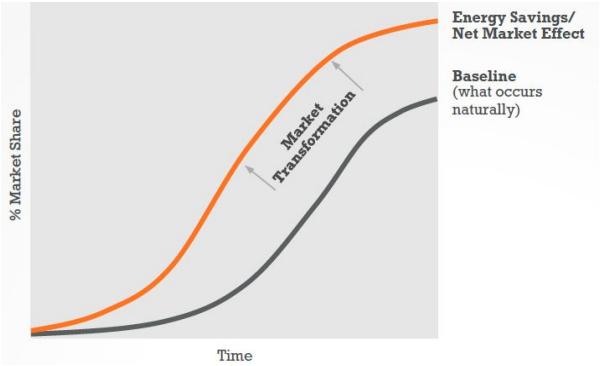


Figure credit: Navigant Consulting. 2019. Energy Efficiency Market Transformation Summit Report. Prepared for ComEd. February. Chicago, IL: Commonwealth Edison

SECTION 03

MAKING A BUSINESS CASE FOR CEA

Making A Business Case for CEA

- US CEA market 2018 trajectory for growth was **3.4% growth rate 2018-2023**
- High efficiency technologies growing even faster ~10%
- More consumer demand for locally and sustainably-grown produce
- Supply chain issues and inflation affect poorest communities the most
- Climate change and pandemic forcing food systems to step up to feed local communities, demonstrate resilience

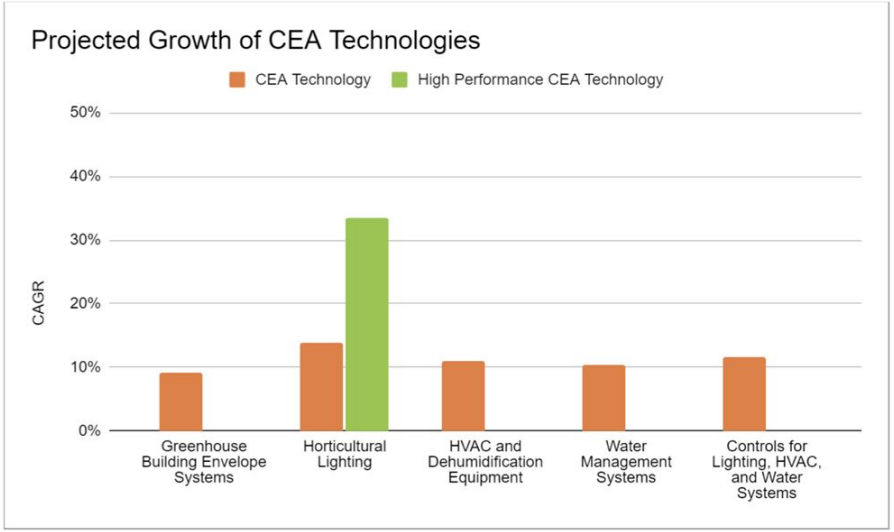


Figure source: RII, CEA Market Characterization Report, 2021.
https://catalog.resourceinnovation.org/item/controlled-environment-agriculture-market-characterization-report-433708

Emerging Areas of CEA

Energy Sources

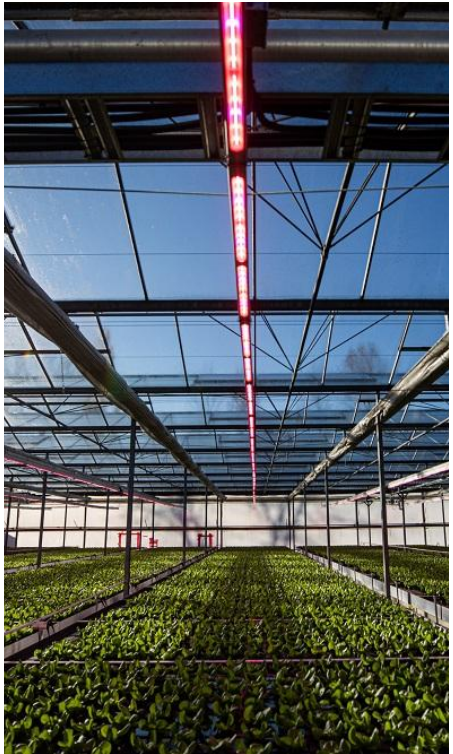
- Heat pumps - geothermal, gas
- Agrivoltaics

Emerging Markets

- Indoor vertical farms
- Mushrooms
- Houseplants
- Community Shared Agriculture (CSA)

Emerging Technologies

- LED grow lights
- Automation/IoT/controls
- Heating systems & heat recovery
- Building envelope
- Irrigation & nutrients



Diverse Facility Types & Complex Activities

CEA market actors are seeking	Utilities and programs are impacted by
• Incentives and on-bill financing for energy efficiency	• Load reduction • Carbon emissions mitigation • Grid resilience • Electrification opportunities
• Interconnections and electric service upgrades	• Load growth
• Integration of renewable energy infrastructure	• Load shifting • Grid resilience
• Accessing trade allies	• Quality and availability of supply chain
• Assistance with understanding or paying their bill	• Energy efficiency opportunities • Demand management opportunities

Challenges for CEA Producers Impacting Utilities and Efficiency Programs

Diverse Crop Types* Grown in CEA Facilities

*This guide covers non-cannabis crop types. Cannabis is also grown in CEA facilities. Best practices for cannabis energy efficiency programs is available on the RII catalog.

Many CEA Building Types

Residential Home Growers

Fruits, Flowers, Herbs, Veggies, Cannabis

Hoop house/ High Tunnels

Fruits, Flowers, Herbs, Veggies, Cannabis

Gable-style Greenhouses

Fruits, Houseplants Flowers, Herbs, Veggies, Cannabis

Indoor Grow Rooms

Herbs, Mushrooms, Cannabis

Drying/Cold Storage

Fruits, Herbs, Veggies, Cannabis

Processing Laboratories

Flowers, Herbs, Cannabis

SECTION 04

CEA PROGRAM DESIGN

Learn CEA Facility Characteristics

Cultivating Canopies in CEA Facilities

Indoor facilities use electricity for cultivation processes like lighting and HVAC and have opportunities for efficiency across a wide range of facility sizes

Variety of production environments

Facility Type[3]	Minimum Canopy Area (square feet)	Median Canopy Area (square feet)	Maximum Canopy Area (square feet)
Greenhouse	13,500	348,000	5,000,000
Indoor	500 (research chamber) 5,000 (production)	60,000	280,000

Canopy Area of U.S. CEA Facilities

Electricity End Uses for Indoor CEA Operations

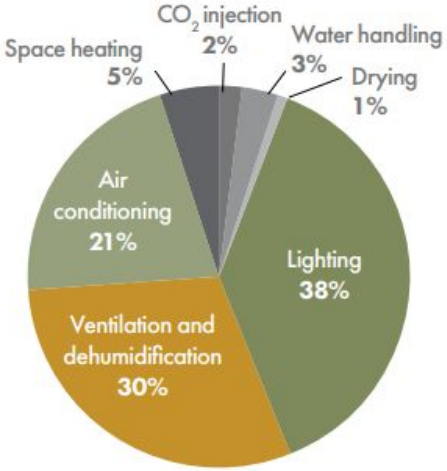


Figure data source: Southern California Edison Market Characterization of Indoor Agriculture (Non-Cannabis), 2021.
https://www.etcc-ca.com/reports/market-characterization-indoor-agriculture-non-cannabis
Table data source: RII, CEA Market Characterization Report, 2021.
https://catalog.resourceinnovation.org/item/controlled-environment-agriculture-market-characterization-report-433708

Choose Your Level of Engagement

Connect to Program Goals

Determine what resources you have

Plan for Subject Matter Experts

CEA can fit under C&I or agriculture programs

Invest in CEA at which depth:

- Passive
- Reactive
- Proactive

Category	Perceived Opportunity to Program Goals	CEA Efficiency Program Approach
Passive	**Small**	• No investment in CEA-specific resources. • Some incentives offered for CEA customers via existing C&I or Ag programs. • Staff have limited experience processing structured custom projects. Staff are directly involved in project management. No subject matter experts (SME). • No proactive engagement in the CEA market. • Higher exposure to realization rate impacts during program evaluation due to lack of SME and rigor.
Reactive	**Medium**	• Some intermittent program investments in cost share opportunities that provide access to tools and resources. Resources develop cultivators to get more projects in the pipeline. • Variety of incentives offered for CEA customers via existing and emerging C&I and Ag programs. • Staff have some experience processing structured custom CEA projects. Staff are directly involved in project management and may leverage additional SME as needed. • Program reactively provides basic market engagement. • Moderate exposure to realization rate impacts during program evaluation due to lack of SME and rigor.
Proactive	**Large**	• Recurring program investments in cost sharing opportunities that provide access to tools and resources. Resources develop cultivators, the design and construction supply chain, and emerging technology to get more projects with more measures in the pipeline. • Variety of specialized incentives offered for CEA customers via dedicated programs and existing C&I and Ag programs. • Staff have substantial experience processing structured custom CEA projects and may work with an implementer SME to provide project management services. • Program proactively provides advanced market engagement. • Lower exposure to realization rate impacts during program evaluation due to lack of SME and rigor.

Levels of Utility Energy Efficiency Program Engagement

Strategic Networking

Participate in CEA Industry Organizations

Several organizations address CEA issues:

- DLC, IES, ASHRAE, AHRI, ASTM

Some organizations are dedicated to CEA:

- RII, GLASE, ASABE, OptimIA

Join RII as a Member

19 utilities and program implementers are members of RII and the Technical Advisory Council

- Participate in RII's Utility Working Group to learn from veteran program managers and network strategically with organizations across North America

SECTION 05

LIGHTING & HVAC MEASURES

Intensity of Horticultural Lighting Applications

Estimate Savings Potential by Crop Type

Many utilities in regions with CEA facilities pursue horticultural LED lighting solutions as their first CEA efficiency measure given their familiarity with C&I LED lighting programs.

- The average horticultural rebate in these states for a 600 W LED fixture replacing a 1,000 HPS fixture is approximately $160
  - Offsets a fixture cost of ~$950 - $1,000
- Programs in 35 states support efficient horticultural lighting equipment
- Inquire from growers about their crop types to understand lighting system type and savings opportunity

Crop Type	Intensity of Horticultural Lighting Demand
Cucumbers	Medium-High
Tomatoes	High
Peppers	High
Greens	Medium
Fresh Herbs	Low-Medium
Strawberries	Medium
Mushrooms	Low
Nursery & Floriculture	Low-Medium

Intensity of Horticultural Lighting Demand

Increase Photosynthetic Photon Efficacy (PPE)

Incentivize Growers to Use High-Performance LED Solutions

Depending on the application, CEA growers choose a variety of equipment types including:

- LED
- High-Intensity Discharge
- Fluorescent

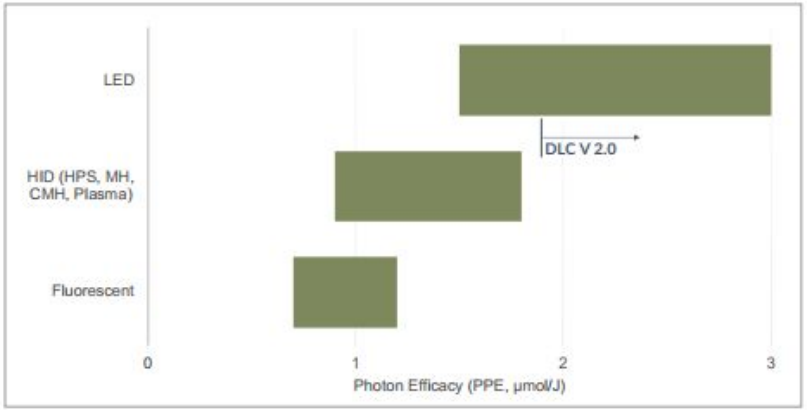
Photon efficacy (PPE) can be the backbone of savings estimates for CEA lighting programs

States like CA are creating PPE minimums for CEA

ASHRAE 90.1 is implementing the same PPE minimums:

- **1.7 for greenhouse µmol/J, 1.9 for indoor µmol/J**

DLC QPL lists products with PPE >1.9 µmol/J (with +/-5% tolerance)



Photosynthetic Photon Efficacy (PPE) by Horticultural Light Fixture Type

Quantifying Performance of Lighting Equipment

Best Practices for LED Offerings

Working with commercial CEA growers

Calculating incentives for LED

- For indoor farmers
- For greenhouse growers

Use key inputs for savings calculations:

- PPE (efficacy)
- PPFD (light intensity or fluence rate)
- DLI (quantity of daily light received)

Characteristic	Sprout / Seedling[9]	Vegetative / Budding	Flowering / Fruiting
Fixture Type	T5 HO T8 T12	HPS	HPS
Wattage Range	60 - 435 W	400 - 1,000 W	650 - 1,000 W
Luminaire PPE Range[10]	0.7 - 1.2 μmol/J	1.0 - 1.7 μmol/J	1.0 - 1.7 μmol/J
Fixture Type[11]	LED	LED	LED
Wattage Range[12]	15 - 200 W	150 - 600 W	150 - 1,200 W
Luminaire PPE Range[13]	1.8 - 3.0 μmol/J	1.8 - 3.0 μmol/J	1.8 - 3.0 μmol/J

Typical Lighting Equipment for Stages of CEA Plant Growth

Horticultural HVAC Applications

Vital Environmental Controls for CEA

HVAC systems can be a second CEA efficiency measure to pursue but can be more challenging to deliver

Energy source impacts savings opportunity

Avenue for electrification / decarbonization

Requires program staff that have:

- Subject matter expertise for a diversity of technologies and growing environments
  - Plant-centric HVAC approaches
- The ability to quickly and accurately calculate savings and incentives
  - Baselines
  - Energy model inputs

	Vented Greenhouse	Sealed Greenhouse	Indoor Vertical Farm
Heating	Unit heaters, hot water systems (boilers connected to radiant warm-floor slab heating or bench heating, hydronic unit heaters, root zone heating), biomass heating, furnaces	Hot water systems, geothermal heat exchange systems, air to air heat exchangers, fan coil units, electric resistance systems, latent heat converters	Electric resistance systems, heat pump systems, hot water systems, heat recovery chillers
Ventilation	Natural ventilation - ridge vents, gutter vents, side wall vents open-roof, retractable roof, powered fan systems for ventilation and exhaust	Sealed greenhouses do not bring in outside air	100% recirculating air
Airflow	Horizontal airflow fans (HAF)	Vertical air fans, destratification fans	HAFs and in-rack fan systems
Cooling	Evaporative fan-and-pad, fog (mist) cooling and humidifying, chillers[15]	High-pressure fogging and integrated cooling & dehumidification	Integrated cooling & dehumidification
Humidity management	Exhaust fans, wood-fired heating, sometimes plug-in dehumidification equipment	Central dehumidification system	

Common CEA HVAC Systems by Facility Type

CEA HVAC Measure Savings Potential

Energy Saving CEA Measure	Energy Savings Potential
Greenhouse Envelope Systems[17]: • Enclosure upgrades • Shade and thermal curtains • Curtain controls	5 - 50%
Horticultural Lighting Systems[18]: • Air-cooled LED light fixtures • Liquid-cooled LED lighting systems • LED lamps • Lighting controls	30 - 40%
HVAC Systems[19]: • Heating systems • Root zone heating systems • Cooling systems • Variable frequency drives (pumps and fans) • Humidity management equipment • Environmental controls • Airflow controls	20 - 30%
Integrated Controls Systems[20]: • Envelope, lighting and HVAC controls integrations • Water and environmental controls integrations	15 - 30%

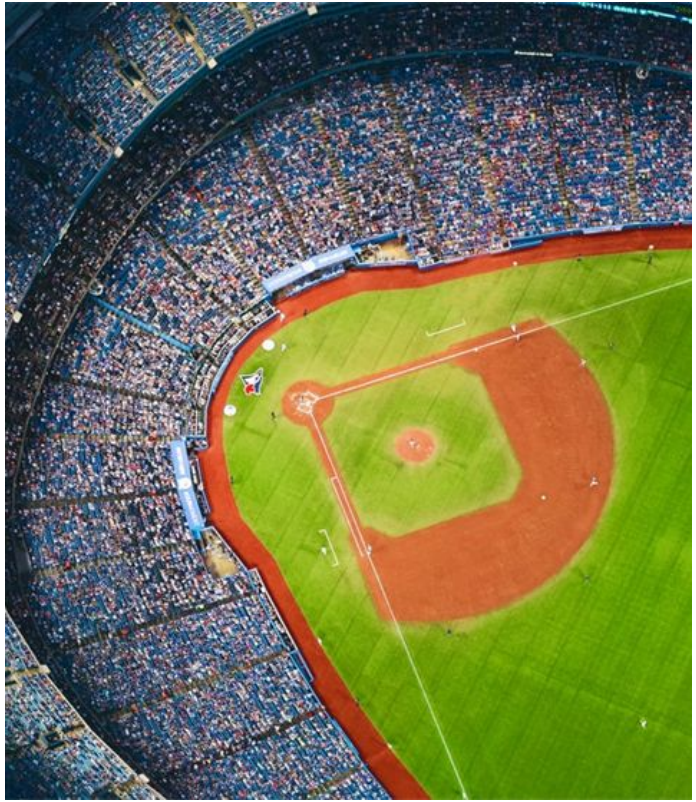
Energy Savings Potential of CEA Measures

SECTION 06

CEA FACILITY BASELINES

Baselines for Energy & Demand Savings

- Establish/agree upon baseline efficiency with evaluators
- Ensure savings integrity
- Proactively avoid surprises
- Maximize savings and incentives



Baselines for Components and Systems

- Lighting technology and controls
  - By crop, stage of growth, and type of facility
- HVAC & Dehumidification and controls
  - Greenhouse vs. fully indoors
  - Ventilation vs. unvented
- Heating systems
- Pumping systems
- Envelope

Baselines can be especially tricky for new construction and when there is no clear governing code or industry standard practice.

Facility Size and HVAC Capacity

Scale of Operations Influences System Choices for Modeling

There is no rule of thumb

Crop type can drive system selection

Existing buildings may have limited options

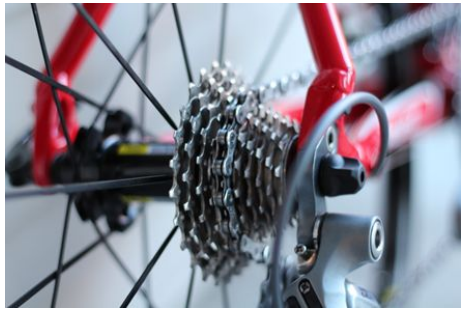
Facility Cultivation Area	HVAC System Capacity	Greenhouse CEA HVAC Solutions	Indoor CEA HVAC Solutions
<10,000 sq ft	75 tons or less	Direct expansion (DX) cooling, unit heaters, passive ventilation via venting of building envelope	Direct expansion (DX) units with standalone dehumidification systems like roof-top units (RTUs) split systems, and ductless heat pumps
10,000 - 30,000 sq ft	75 - 300 tons	Evaporative cooling walls (pad & fan systems), radiant heating systems, exhaust and circulation fans	Air-cooled chillers, hot water coils, heat pump systems, electric heat
>30,000 sq ft	Greater than 200 tons	Ground-source heating systems, comprehensive ventilation systems	Water-cooled chillers, heat recovery systems, comprehensive ventilation system

Typical CEA HVAC System Types by Facility Size and HVAC Capacity

Existing Baselines

Consider the electric and gas savings from:

- TRMs
- Industry Standard Practices
- IECC 2021
- ASHRAE 90.1 – 2019
- California Title 24
- MA, IL
- ASABE Standards, Engineering Practices (like EP653)
- Others
  - DLC Technical Requirements for Hort Lighting
  - Benchmarks / modeling
  - Pre- and post-project PowerScore KPIs
    - Existing facility
    - Existing practices



Shifting Baselines

Programs must stay up-to-date with rapidly-changing industry trends, technologies, and practices that may require mid-program changes

SECTION 07

SAVINGS METHODOLOGIES & INCENTIVE STRUCTURES

Custom & Structured Custom Approaches

Programs will need to be structured differently based on customer base and existing offerings

No one-size-fits all

- Augmenting existing offering or starting from scratch
- Custom project approaches provide specificity to capture variability among facilities
- Building depth and breadth of projects can streamline savings and incentive calculations

	Custom	Prescriptive	Structured Custom
Greenhouse Covering Incentives	54%	38%	8%
Lighting Incentives	40%	35%	25%
HVAC Incentives	55%	28%	17%
Controls Incentives	67%	20%	13%

Prevalence of Savings Methodologies for CEA Program Offerings

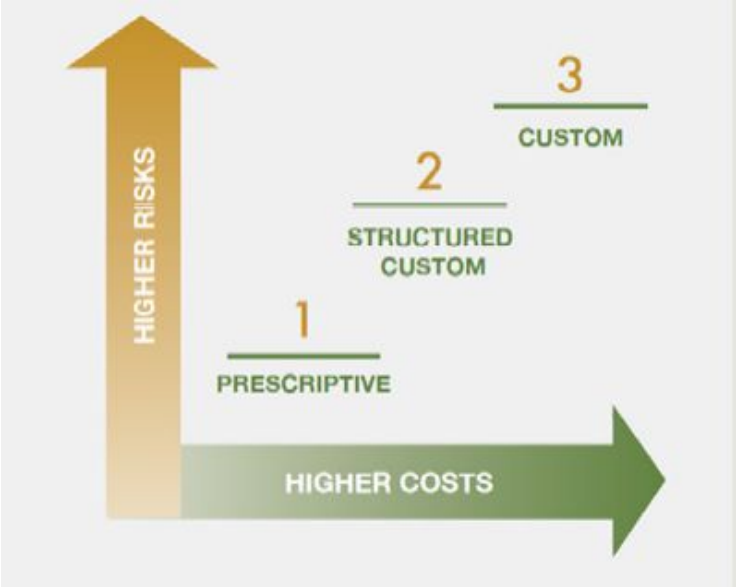
Prescriptive Approaches

After Evaluation of Custom Projects

Scale up with enough historical projects

Reduce risk and lower program costs by:

- Focusing on the subset of technologies and measures with the most data
- Repackage existing programs with adjusted inputs
- Clearly defining eligibility requirements



Risk and Cost impacts of Different Program Approaches

Financial Incentive Offerings

Provide Flexibility

Support a diversity of customers

Encourage many to participate with defined benefits

Given the dynamic nature of the industry, keep options open by:

- Provide structure for multiple technologies
- Understand where each technology falls on the custom-prescriptive risk/cost spectrum

Savings Metric	Incentive Range	Incentive Structure Notes
$/kWh	$0.009/kWh (net lifetime) to $0.45/kWh (custom) Average $0.14/kWh	Low end: dehumidifiers High end: LED horticultural fixtures
$/kW	$68 - 500/kW Average $237/kW	Offers load shifting and time of use benefits
$/Watt	$0.09/Watt - $1/Watt Average $0.47/Watt	Prescriptive or structured custom programs for LED horticultural fixtures and daylighting controls
$/unit	$50 - 250 / fixture for LED light fixtures	Prescriptive or structured custom programs for LED horticultural fixtures
$/hp	$20 - 200 / hp	Prescriptive or structured custom programs for process VFDs
$/sq ft	$0.02 - 0.50 / sq ft Average $0.18 / sq ft	Infrared (IR) polyethylene greenhouse coverings
$/sq ft	$0.03 / sq ft - $0.25 / sq ft Average $0.11/sq ft	Greenhouse controllers
$/sq ft	$0..5 / sq ft - $1.17 / sq ft Average $0.45 / sq ft	Greenhouse thermal curtains

Incentive Structures and Savings Metrics

SECTION 08

STRATEGIC ENERGY MANAGEMENT

Case for Continuous Improvement

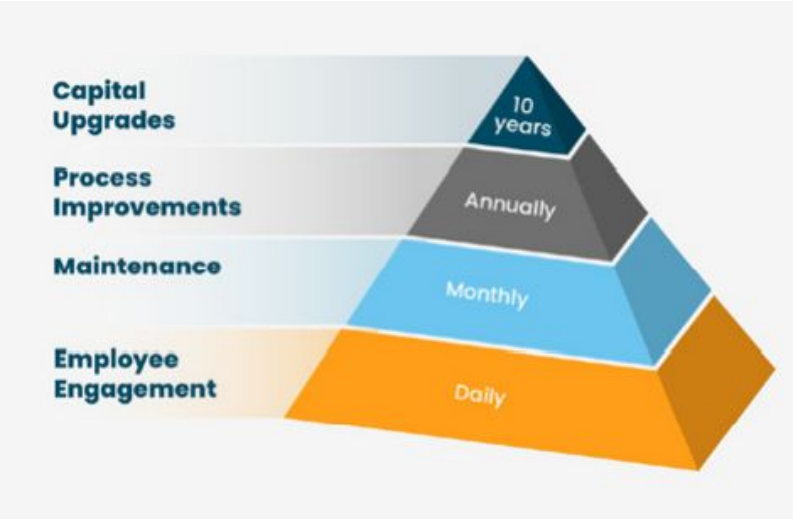
Systematic continuous improvement approach

Strategic energy management (SEM) strategies can be applied for CEA customers and facilities

SEM programs can deliver cost-effective savings and increase the equity of CEA programs through:

- Technical support
- Organizational commitments
- Energy champions
- Benchmarking
- Energy Modeling
- Peer-to-peer learning
- Cohorts open to all sizes
- Self-serve options

Which all leads to improving business competitiveness



Strategic Energy Management Activities

Strategic Energy Management for CEA – Lessons Learned

Enthusiastic participation can be expected

- Customers value technical expertise, prioritized opportunities, and team accountability
- Mixed cohort may be best

Modeling can be especially challenging

- Seasonality of production, varying room temperatures, solar gains, summer operation
- Bottoms-up engineering calculations may be required

Customer engagement

- Reduce skepticism – bring your experts!
- Use tried and true recruitment techniques
- Avoid harvest/busy seasons
- Involve key personnel in the energy team – growers need to be aware

CEA Isn't [That] Unique

Successful outcomes rely on same themes as those for conventional participants

- Leadership support
- Team engagement
- Consistent communication
- Accountability

Similar measures as with conventional participants

- Maintenance & preventative maintenance
- Setpoint adjustment
- Sensor calibration
- Turn it off / shut the door / awareness campaigns

Results for CEA Facilities Stack Up Against Conventional Participants

Mushroom grower
Yr 1: 2.5%
Yr 2: 6.5%
Yr 3: ??
kWh reduction

3% natural gas savings first year greenhouse

12% electricity savings in cut flower greenhouse

4% natural gas savings at nursery

SECTION 10

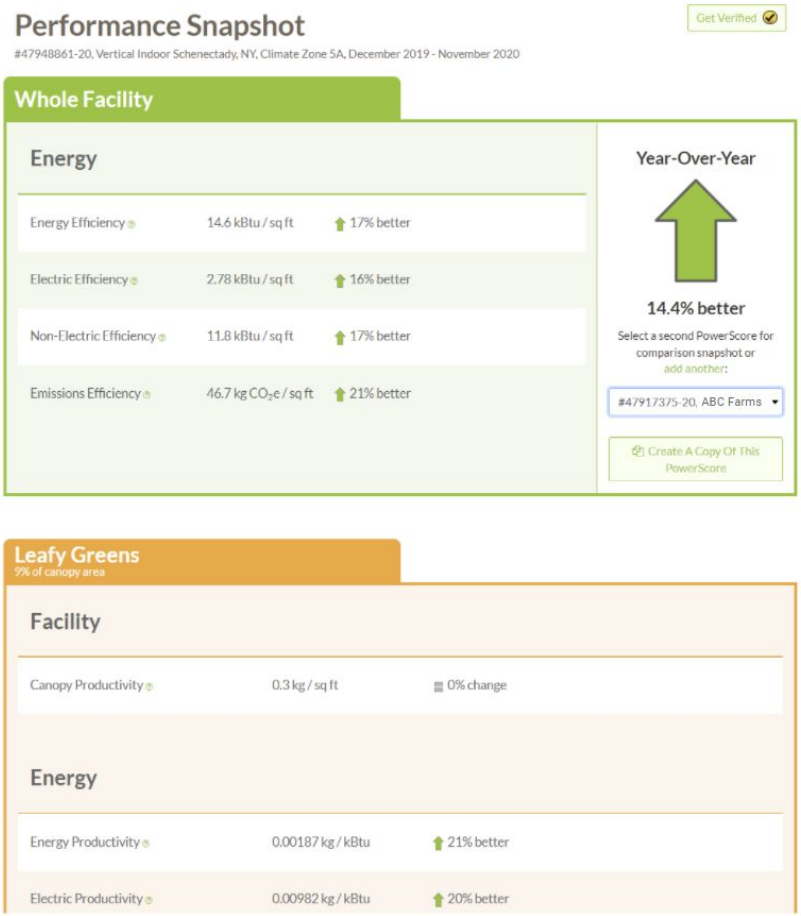
RESOURCE BENCHMARKING CEA FACILITIES

Benchmarking: PowerScore

Validate Performance & Savings with Benchmarking

PowerScore

- Energy kBtu / sq ft
  - Electricity & Other Fuels
- Energy lbs / kBtu
  - Electricity & Other Fuels
- Emissions tons CO2e / sq ft
- Emissions lbs / tons CO2e
- Water gallons / sq ft
- Water lbs / gallons
- Waste lbs / sq ft
- Waste lbs / lbs



Get Started with PowerScore

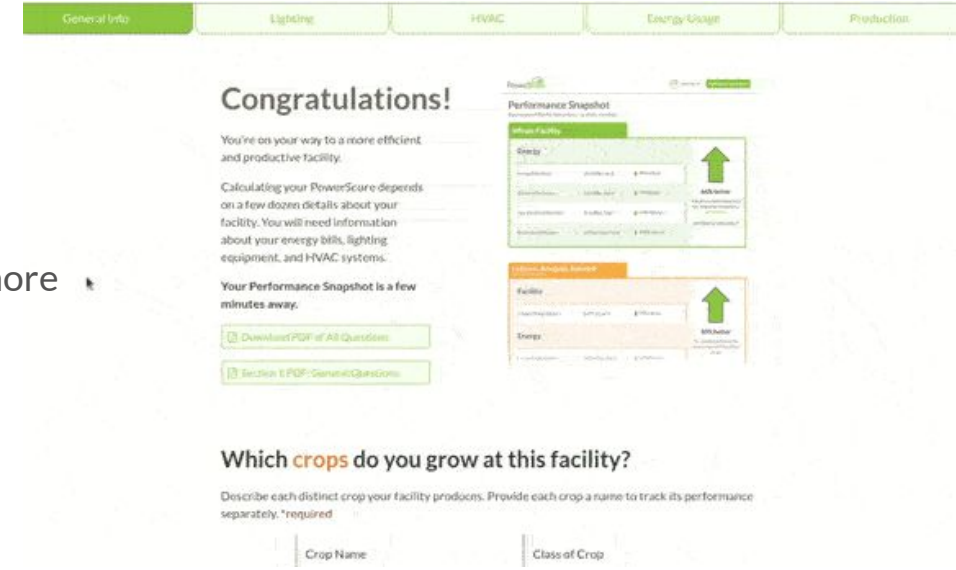
Create Performance Snapshots to get KPIs

PowerScore

Visit ResourceInnovation.org/PowerScore to learn more

Use the online survey at
powerscore.resourceinnovation.org/go-cea

Schedule a benchmarking session with
RII Engineering team at
calendly.com/carmen-rii



SECTION 11

CEA PROGRAM MARKET ENGAGEMENT

Program Products and Services

Develop and deploy strategic communication, products, and services for your CEA customers

Key content considerations:

- Speak their language
- Know how they grow
- Accessibility
- Build bridges

Products	Services
Information sharing and technical tools directly used by program staff and/or customers	Involve a subject matter expert performing services on behalf of the efficiency program
Lower cost investment Passive or reactive levels of engagement Dependent on program staff and customers to leverage them	Higher cost investment Proactive engagement to develop and serve the utility market External service providers generate positive demand cycle for program offerings
CEA program websites Savings calculators Resource benchmarking platforms	Educational curriculum Virtual classrooms Live workshops

CEA Program Offerings

Technical Assistance

Support growers with subject matter experts

Implementers and consultants can elevate programs through:

- Supporting projects
- Engaging the supply chain
- Training up staff

Technical Support Areas	Cultivator Benefits	Program Benefits
Selecting facility sites	Flag electric and gas service increases	Expose customers to program offerings early
Estimating energy consumption and demand	Forecast monthly and annual energy bills	Educate customers so they can succeed
Understanding program eligibility requirements	Assess facility for projects and incentives	Streamline program implementation
Understanding product eligibility requirements	Understand available efficient equipment	Devote time to eligible customers
Designing profitable facilities	Identify efficiency opportunities	Increase participation in programs
Determining feasibility & cost effectiveness	Make decisions about efficiency projects	Increase number of customers program can serve
Estimating energy savings and potential incentives	Maximize return on investment	Produce valid savings claims at attractive yield rates

Common Areas Covered by CEA Subject Matter Experts

Educational Curriculum and Training

Develop educational programming for CEA customers outside of basic program landing page

Connect cultivators to program by:

- Raising awareness
- Highlighting research
- Building the pipeline
- Developing the workforce and supply chain

Efficient Yields
Best practices on energy, water efficiency, and productivity

Harvesting Savings
Best practices on energy efficiency for indoor agriculture

Growing Efficiency
Best practices on design and construction for horticulture

CONTACT US

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